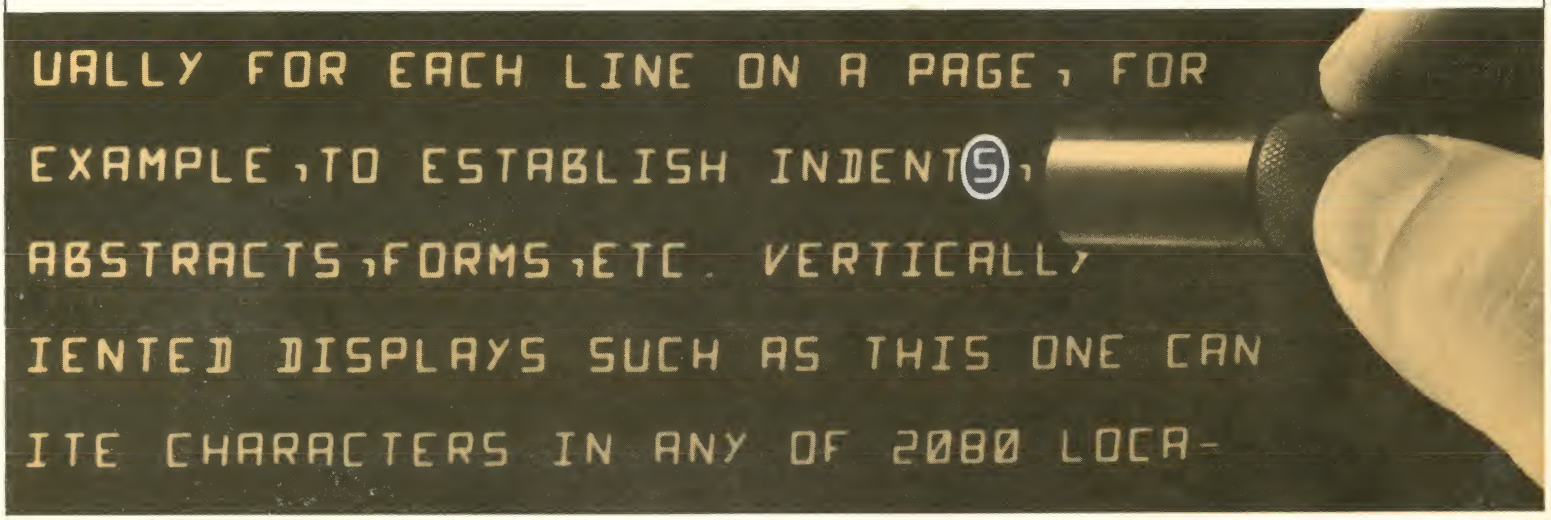
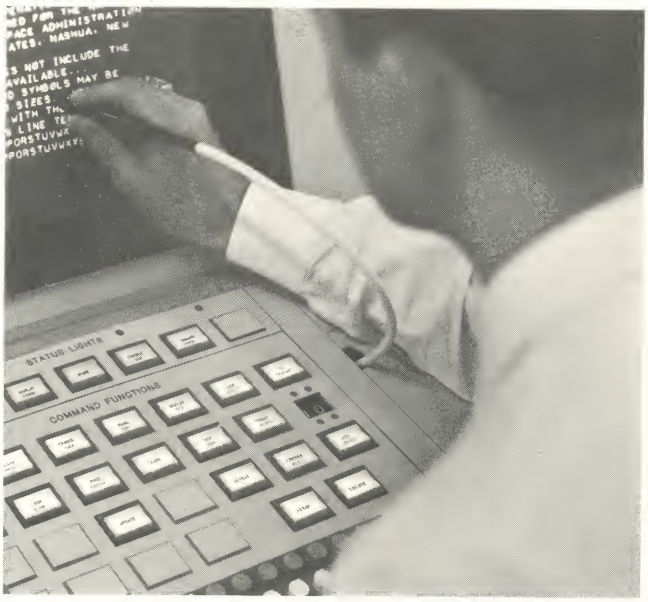
Sanders New Ultra-fast Solid State PHOTOPEN® Light Sensing System



SANDERS NEW SOLID STATE PHOTOPEN® LIGHT SENSING SYSTEM

Combines Ultra-fast Response with Precise Symbol Detection for Editing and Control of CRT Displays

- ☐ ***All Solid State***
- ☐ ***Very Fast Response***
- ☐ ***Very High Sensitivity***
- ☐ ***No False Triggering***
- ☐ ***Exact Pen Positioning Guide***



Sanders new solid state PHOTOPEN system is a very sensitive light detection system with exceptionally fast response characteristics. It is specifically designed for symbol sensing and editing functions in modern, high data rate CRT displays. With suitable editing logic, the PHOTOPEN system can be used to implement, erase, add, correct, copy, transfer, and performs other functions in different displays. It can be used with a variety of character generation techniques including shaped beam, monoscope, stroke, and dot matrix types. The PHOTOPEN system can also be used to control generation and positioning of vectors when used with appropriate display circuitry.

The PHOTOPEN system's optical receiver is a lightweight, hand-held pen unit, similar in size and weight to a fountain pen, that can be positioned over the face of the CRT. It accepts only light from a small area on the CRT face precisely defined by an illuminated finder circle projected by the pen unit optics. Light pulses from the sampled area are detected by a phototransistor element in the pen unit and are transmitted to a separate solid state electronics unit. The detector output is amplified, thresholded to remove noise, and applied to a multivibrator which produces a standardized electrical output pulse for each light pulse received by the pen unit.

The light detection optics and electronic circuits are designed for ultra fast response, thus the PHOTOPEN system output pulse is very nearly coincident with the leading edge of the CRT light pulse.

A microswitch on the pen unit barrel gives the display operator complete control over the PHOTOPEN system output. No output is produced while the pen is being positioned over a symbol. When positioning is complete, slight pressure on the microswitch unblanks the electronics to gate the output on.

Because of its unique design, Sanders PHOTOPEN system has several important advantages over other light sensing devices for use with CRT displays. These include:

- ☐ *Very fast response, with typical delay of less than 1 microsecond.*
- ☐ *Very high sensitivity adjustable over a wide range.*
- ☐ *Complete elimination of false or multiple triggering.*
- ☐ *Exact pen positioning guide.*

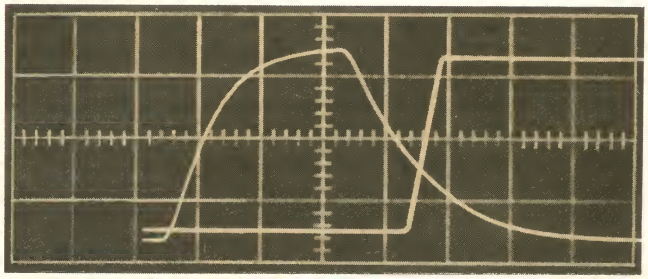
FAST RESPONSE

To achieve a fast, stable response time (minimum input to output delay), the Sanders PHOTOPEN system employs a very sensitive phototransistor detector, and associated electronics having an extremely high gain-bandwidth product.

Because of this design, the delay between receipt of a light pulse and production of an output pulse is typically between 0.5 and 1.0 microsecond. This delay range is set by the inherent light output rise time capability of the CRT phosphors and the symbol brightness level used rather than speed limitations of the PHOTOPEN system.

The standard PHOTOPEN system is designed to trigger on the change of light intensity sensed as a character or symbol is written on the CRT. The phototransistor and associated electronic circuitry used in the Sanders PHOTOPEN system are insensitive to steady-state light conditions, and will not trigger on long-persistance phosphors, ambient lighting, or reflections from the CRT face and implosion shield.

The minimum delay specified can be achieved with displays having a wide range of writing and sweep rates. With swept-beam displays, the PHOTOPEN system will operate over a range of writing rates from 1 microsecond to 200 milliseconds per centimeter and sweep frequencies up to 50 kHz. With pulsed-beam displays, the PHOTOPEN system will operate with writing pulse rates from 0.2 microsecond to 1 millisecond at repetition rates up to 50 kHz.



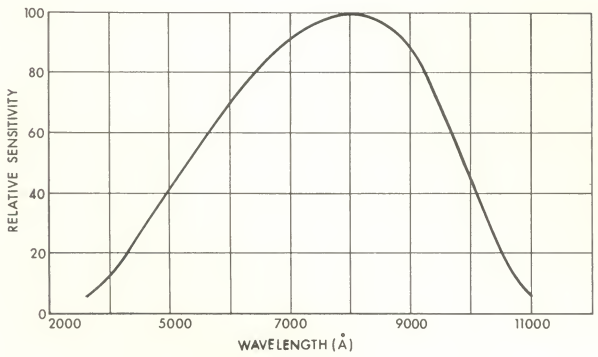
The left-hand trace shows a pulse input to a Tektronix RM45A oscilloscope with a P-2 phosphor. The right-hand trace shows the PHOTOPEN® system output resulting from optical detection of the leading edge (at the 50% point) of the left-hand pulse. Oscilloscope calibration is 0.2 microsecond per centimeter, 20 volts per centimeter (left-hand trace), and 2 volts per centimeter (right-hand trace).

The standard PHOTOPEN system output pulse has an amplitude of +5 volts ±1 volt, width of 10 microseconds ±10%, and rise time of approximately 0.1 microsecond. It is a dc coupled output with design nominal impedance of 200 ohms. For applications requiring outputs with different electrical characteristics, Sanders can supply PHOTOPEN system output pulse transformers to provide any desired impedance, amplitude, polarity, and dc isolation at small additional cost.

HIGH SENSITIVITY

In addition to fast response, use of a phototransistor detector gives the PHOTOPEN system maximum sensitivity, which can be set to such a high level under various lighting conditions that the unit will trigger on CRT symbols too dim to be seen by the human eye. This is accomplished by the unique Sanders technique of prebiasing (or presensitizing) the transistor with a portion of the light generated for the pen positioning guide. In this manner, the transistor is always biased to the point where only an extremely small amount of additional light is necessary to produce an output pulse. No display application has ever been found which required use of the PHOTOPEN system's maximum sensitivity capability.

A sensitivity adjustment is provided on the front panel of the PHOTOPEN system electronics unit to allow optimization for specific applications. With very bright displays, sensitivity can be reduced to completely prevent false triggering on light scattered from characters closely adjacent to the one desired.



Spectral response curve, which is typical for the Sanders PHOTOPEN® system.

Once set for a given application, sensitivity readjustment is not normally required because the PHOTOPEN system is specifically designed to maintain optimum operation over a very wide dynamic range of input light levels. That is, the PHOTOPEN system can operate satisfactorily without readjusting the primary sensitivity control even though ambient light levels and symbol brightness levels are varied over a wide range.

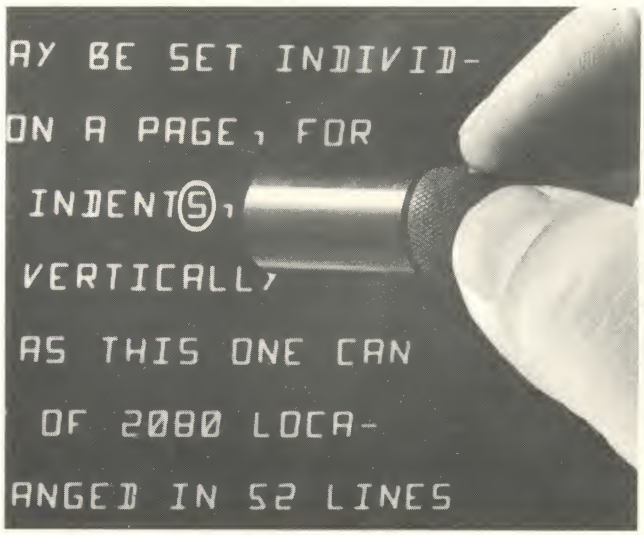
Protection against sudden exposure to very high light levels is inherent in this device as the transistor will merely saturate and no permanent damage will occur.

The standard PHOTOPEN system is ideally suited for use with many of the phosphor types most commonly employed in alphanumeric, television, radar, and oscilloscope displays.

EXACT PEN POSITIONING GUIDE

To aid in operator positioning, the PHOTOPEN system projects an illuminated finder circle on the CRT phosphor enclosing the exact area being sampled by the detector. The finder circle is projected by the same optics used for detection, thus it always exactly encloses the detection area regardless of how far the pen is held from the CRT or how it is positioned over the face of the tube.

No parallax can exist between the detection area and the area enclosed by the finder circle. Any deviation suffered by the light rays from symbol to pen on passing through various media (implosion shield, filters, CRT face, etc.) will be suffered in equal amounts by finder circle rays passing from pen to CRT. This unique system can produce a significant reduction in the number of operator positioning errors compared with other symbol sensing techniques. The operator knows the exact area being sampled at all times in all situations and he knows the proper focal distance to hold the pen from the CRT face.



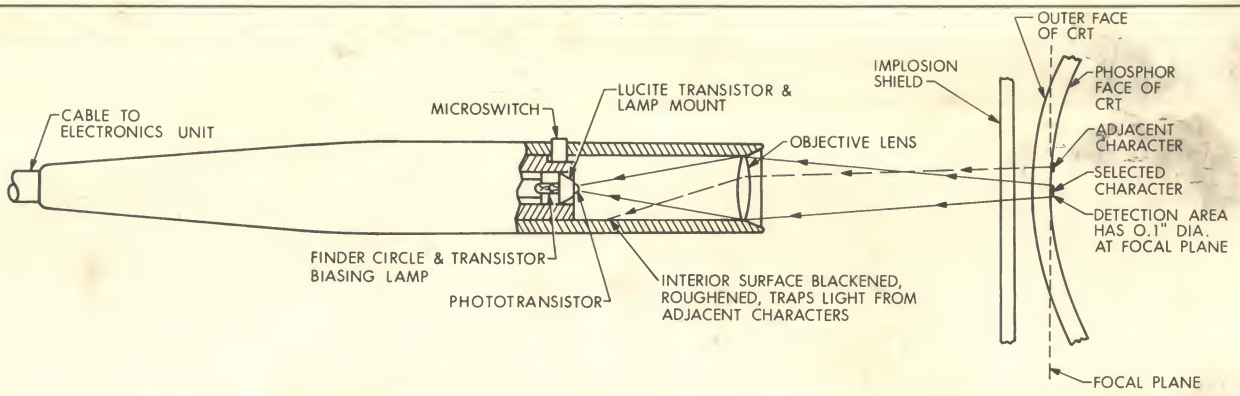
To aid in positioning the pen unit over a desired symbol, an illuminated finder circle is projected on the CRT phosphor surface. The finder circle always exactly encloses the detection area.

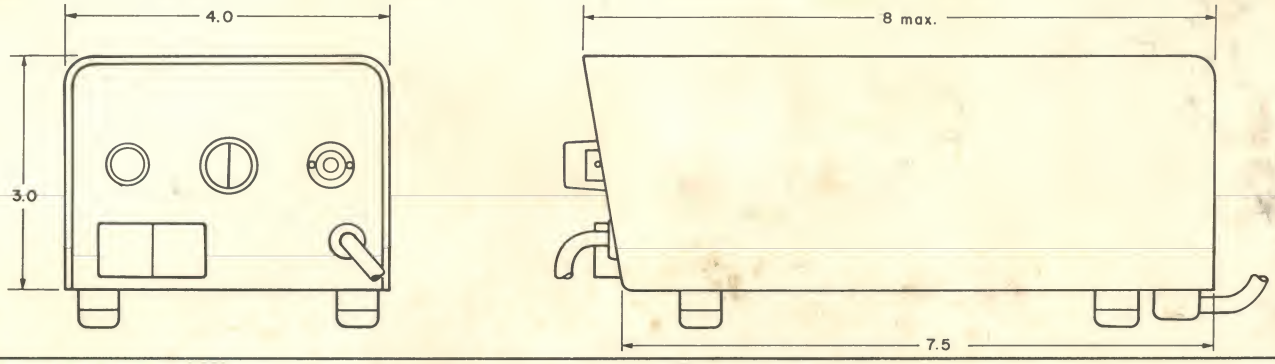
OPTICAL DESIGN

The optical geometry of CRT symbol sensing with the PHOTOPEN system is illustrated on the following page. Three miniature lights are spaced equidistantly around the phototransistor both to generate the finder circle beam and to provide optical biasing for the phototransistor. This finder circle encloses a detection area of 0.1 inch in diameter at the design focal length.

The focal length and detection area size of the standard PHOTOPEN system were selected as most suitable for the majority of display system applications. PHOTOPEN models with different focal lengths and detection area sizes can be obtained on special order. Changes in detection area will alter the pen's sensitivity somewhat.

The pen's inner surface is blackened and roughened to trap scattered light from characters adjacent to the one desired, and prevent this scattered light from illuminating the phototransistor.





SPECIFICATIONS

Spectral Response:
approximately 4000 A to 11,000 A.

0.625 inch from end of pen; other focal lengths on special request.

Detection Area:
circle with 0.1 inch diameter at focal point standard; other sizes on special request.

Sensitivity:
adjustable to trigger on light pulses from below human visual threshold (in normal room ambient) to above eye comfort brightness; not affected by ambient light, reflections from CRT face and implosion shield, or long phosphor persistance.

Input to Output Delay:
less than 1 microsecond, depending on phosphor characteristics and operating brightness level.

Response:
Swept-Beam Displays:
will detect light pulses from displays with writing rates from 1 microsecond to 200 milliseconds per centimeter at repetition rates to 50 kHz.

Pulsed-Beam Displays:
will detect light pulses from displays with writing pulse widths from 0.2 microsecond to 1 millisecond at repetition rates up to 50 kHz.

Output:
pulse with +5 volt ±1 volt amplitude, 10 microsecond ±10% width, dc coupled with 200 ohm nominal impedance standard; other amplitudes, polarities, and impedances on special request.

Finder Circle:
illuminated yellow circle exactly enclosing detection area.

AC Power Requirements:
115 VAC 50 to 400 Hz, 7 watts.

Size:
Pen Unit:
5 inches long, approximately 0.625 inch diameter in hand grip area.

Electronics Unit:
4 inches wide x 8 inches long x 3½ inches high.

Weight:
entire system weighs only 2½ lbs., including associated power supply and electronics.

Probe Cable:
40 inches long.

Operating Temperature Range:
0°C to +50°C.

SANDERS ASSOCIATES, INC.
MICROWAVE DIVISION
Creating New Directions in Electronics

For further information, applications, and price quotations on the standard solid state PHOTOPEN Light Sensing System or on special designs for particular applications, contact the Microwave Division, Sanders Associates, Inc., Nashua, New Hampshire 03060. Telephone (603) 883-3321, Ext. 7291.

Continuing research and improvement may result in specification or price changes at any time.

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